Energy and Centrality Dependence of Rapidity Densities at RHIC *

Xin-Nian Wang and Miklos Gyulassy

The measured $dN_{ch}/d\eta(|\eta| < 1)$ for central collisions was reported to agree within statistical and systematic errors with the default HIJING1.35 predictions. Of course, one cannot conclude that the dilute HIJING1.35 initial conditions (with $dN_{glue}(p_T > 2 \text{ GeV})/dy \approx 250$ at $\sqrt{s} = 130$ AGeV) are correct without much more extensive differential experimental studies, especially of the shape of $dN_{ch}/d\eta$ and the high p_T hadron spectra. Other models, such as parton saturation models, that assume local equilibrium and hydrodynamic expansion can also reproduce the first data starting from much higher initial conditions. The aim of this letter is to emphasize that the centrality or impact parameter dependence of the charged particle rapidity density provides a key observable that, combined with other differential measurements, can significantly narrow the current band of uncertainty of the initial conditions produced at RHIC and search for evidence of novel gluon saturation phenomena or dynamical screening effects at high density.

Shown in Fig. 1 are the $dN_{ch}/d\eta$ per participant pair as functions of $\langle N_{part}\rangle$ at three different energies together with the RHIC data by PHOBOS experiment [1] and the $pp(\bar{p})$ data. The HIJING results increase monotonically with the number of binary collisions per participant $\langle N_{binary}\rangle/\langle N_{part}\rangle$. The slope increases with energy since the hadronic multiplicity is proportional to jet cross section which has a significant energy dependence. For very peripheral collisions, the results agree with $pp(\bar{p})$ data because that is how the model parameters of HIJING are constrained. Naively, $\langle N_{binary}\rangle/\langle N_{part}\rangle \sim \langle N_{part}\rangle^{1/3}$.

The dot-dashed lines are the predictions extrapolated from EKRT saturation model. Contrary to HIJING predictions, the saturation model gives increasing multiplicity per participant toward more peripheral collisions. While the extrapolation to the highest impact parameter (low participant number) domain is dubious, a general feature of saturation models is expected to be a weakly decreasing or constant dependence on centrality in semi-peripheral to central collisions. The upcoming experimental data should easily distinguish these two widely different predictions.

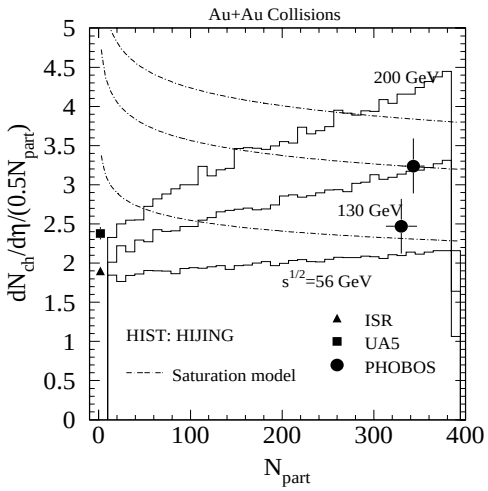

Figure 1: The charged particle (psuedo) rapidity density *per participating baryon pair* is shown as functions of the number of participant baryons for central $Au + Au(b < 3\text{fm})$ collisions at $\sqrt{s} = 56$, 130 and 200 AGeV. Results of HIJING1.35 (solid histograms) are compared to $pp(\bar{p}$ and PHOBOS data and to EKRT predictions (dot-dashed).

Footnotes and References

*LBL-45309, to appear in Phys. Rev. Letters.

†[1] PHOBOS Collaboration, B. B. Back et al, Phys. Rev. Lett. **85**, 3100 (2000).